Benefits of Meditation

(This article is complementary material for Tutorial 2)

Meditation is often credited with helping people feel less anxious, more focused and energetic, but are the benefits measurable?

Recent advances in medical imaging allow detailed studies that are reshaping our understanding of the effects of meditation on neural behavior. Already there are several basic effects that have been discovered through scientific research in the recent past which demonstrate the profound influence meditation has on neurophysiology.

You may have heard that meditation is a great way to relieve anxiety, increase focus, and improve relaxation. You may also have heard of people with depression or burnout making great improvements thanks to meditation. In this article we examine the proof -what happens in the brain during meditation to bring about these positive benefits.

For all studies cited, numbered references are given at the end, followed by a list of further research if you would like more information.

Meditation and Health

In the 1970s, Harvard Medical School cardiologist Herbert Benson found that even a very simple form of meditation produced sustained physiological benefits such as reduced heart, metabolic, and breathing rates. His 1975 book The Relaxation Response detailed the first scientific validation of meditative practice and fostered the growth of anxiety reduction practice in workplaces, hospitals, and other settings.

Since then we have been able to study meditative states with ever-improving neurotechnology. In 1987 a comprehensive statistical "meta-analysis" was conducted that compared the findings of 31 physiological studies on meditation and on resting with eyes closed. The study evaluated three key indicators of relaxation and found that meditation provides a far deeper state of relaxation than does simple eyes-closed rest. The research showed that breath rate and plasma lactate decrease, the basal skin resistance increases, significantly more during meditation than during eyes-closed rest.

Interestingly, immediately prior to the meditation sessions, meditating subjects had lower levels of breath rate, plasma lactate, spontaneous skin conductance, and heart rate than did the controls. This deeper level of relaxation before starting the practice suggests that reduced physiological stress through meditation is cumulative. [8]

A study of health statistics on over 2,000 people practicing meditation over a five-year period found that meditators consistently had less than half the hospitalization than did other groups with comparable age, gender and profession. The difference between the meditation and non-meditation groups increased in older-age brackets. In addition, the meditators had fewer incidents of illness in seventeen medical treatment categories, including 87% less hospitalization for heart disease and 55% less for cancer. The meditators consistently had more than 50% fewer doctor visits than did other groups. [13]

Meditation and Immunity

In 2002, neuroscientist and immunologist, Kevin J. Tracey [4] discovered that the brain and the immune system are linked through the vagus nerve, a large nerve that begins in the brainstem and travels all the way through the torso.

One of his current studies is exploring how this connection enables us to control our immune systems-at least to some degree-with our minds. His interest is in how we can bring the link into conscious awareness and control, in good old-fashioned neurohacking tradition.

The vagus nerve controls the production of tumor necrosis factor (TNF), a protein that signals the body to mount an inflammatory response. While this is beneficial in the case of fever in combating infection, it can also be triggered in anxiety, emerging as arthritis and other inflammatory diseases.

Meditation slows the heart rate via signals that travel down the vagus nerve. Those same signals, Tracey speculates, may also dampen immune response, making it possible for people to ease the symptoms of inflammatory diseases through exercises such as meditation and yoga.

Meditation and Autonomic Nervous System Changes

Subjects were measured for changes in breathing rate, blood pressure and cholesterol levels during the practice of meditation.

Breath rate fell from 14 breaths per minute to about 11 breaths per minute, indicating meditation produces a state of rest and relaxation. The change in breath rate is natural, effortless, and comfortable. [14]

In a clinical experiment with elderly African Americans (mean age 66) dwelling in an inner-city community, meditation was compared with the most widely used method of producing physiological relaxation. Subjects who had moderately elevated blood pressure levels were randomly assigned meditation, Progressive Muscle Relaxation (PMR), or usual care. Over a three-month interval, systolic and diastolic blood pressure dropped by 10.6 and 5.9 mm Hg, respectively, in the meditation group, and 4.0 and 2.1 mm Hg in the PMR group, with virtually no change in the usual care group. A second random assignment study with the elderly conducted at Harvard found similar blood pressure changes produced by meditation over three-months (11 mm Hg for systolic blood pressure). [15]

A longitudinal study showed that cholesterol levels significantly decreased through meditation in hypercholsteolemic patients, compared to matched controls, over an eleven-month period. [16]

Meditation and Brainwave Activity

Neuroscientists have found that meditators shift their brainwave activity to different areas of the cortex in ways that may be balancing out overactive brain networks. Brain waves in overactive areas of the frontal cortex calm down, and people feel calmer and happier than before.

EEG coherence increases between and within the cerebral hemispheres during meditation. EEG coherence is quantitative index of the degree of long-range spatial ordering of the brain waves. In a new meditator, the EEG coherence increases during the period of meditation. In a person who had been meditating for 2 years, spreading of coherence occurs even before meditation begins, spreading of coherence to high and lower frequencies about half way through the meditation period, and continuing high coherence even into the eyes-opened period after meditation.[6]

Field independence has been associated with a greater ability to assimilate and structure experience, greater organization of mind and cognitive clarity, improved memory, greater creative expression, and a stable internal frame of reference. The results show that practice of meditation techniques develop greater field independence. [7]

Meditation and Anxiety

Several studies have demonstrated that subjects who meditated for a short time show increased alpha waves and decreased anxiety and depression. Meditation practitioners display more relaxed physiological functioning, greater reduction in anxiety, and reduced tension when compared to control subjects [11]

Plasma cortisol is an anxiety hormone. Studies show that plasma cortisol decreases during meditation, whereas it does not change significantly in controlled subjects during ordinary relaxation. [17]

A statistical meta-analysis of 198 independent treatment outcomes found that meditation produced a significantly larger reduction in tobacco, alcohol, and illicit drug use than either standard substance abuse treatments (including counseling, pharmacological treatments, relaxation training, and Twelve-Step programs) or prevention programs (such as programs to counteract peer-pressure and promote personal development). This meta-analysis controlled for strength of study design and included both heavy and casual users. Whereas, the effects of conventional programs typically decrease sharply by three months, effects of meditation on total abstinence from tobacco, alcohol, and illicit drug ranged from 50% to 89% over a 18 to 22 month period of study. [18]

Meditation practitioners report significant reductions in health problems such as headaches and backaches, improved quality of sleep, and a significant reduction in the use of hard liquor and cigarettes, compared to those in control groups.[12]

Meditation and Cognitive Function

One main thing meditation seems to do is improve alertness by offsetting the effects of sleep deprivation. Most people lead lives with unnatural sleep cycles, so this is a strong benefit to memory and cognitive skills.

When researchers tested the alertness of volunteers, they found that meditation proved more effective than naps, exercise or caffeine.

The study [1], took 12 students who had not meditated before and taught them the basics in two short sessions.

Then, over a series of weeks, the students were asked to come in and take tests devised to measure skills like response time. The tests involved a series of visual cues on a display screen that the volunteers had to respond to by pushing the correct button.

The students were asked to take the tests in mid- to late afternoon, when people tend to be sleepiest. They did so before and after 40 minutes of meditating, napping or exercising, or after taking caffeine.

Meditation proved the most effective at maintaining cognitive function. When some of the students were asked to skip a night's sleep and then take the test, meditation was even more helpful.

Earlier studies have found that people are awake while meditating but that their brains undergo changes similar to patterns found in sleep when defragmenting memories for permanent storage. People who meditate a lot report sleeping less, so meditation appears from the evidence to serve some of the same functions as sleep.

A second study [2] examined changes in brain physiology during Kirtan Kriya meditation using SPECT imaging. They found several changes:

1. The left posterior parietal lobe, a region known to modulate spatial orientation, was

deactivated during meditation. At the point when this happens, participants report a sense of transcendence or detachment.

2. The subjects also reported an increased sense of focus and capacity for concentration, although the study did not find increased activation in the attentional networks of the brain. This suggests that it is the act of focusing or 'observing' during meditation that improves concentration.

3. The researchers also found heightened activity in frontal networks in the areas associated with working memory (network 6) and language (N4 & N5).

4. Deactivation in a region called the subgenual cingulated gyrus (which affects visceromotor control) might explain subjective reports of happiness and a sense of well-being while meditating.

The researchers began the study after reports of improvement in Alheimers patients and post-stroke victims when they were taught to meditate. The results offer evidence that this form of meditation changes brain function in a way that was consistent with the positive benefits they observed in such patients.

This is further explored in study [3] which focused on attention. This team studied 17 volunteers, ages 22 to 64, who attended a 3-month-long meditation retreat. They spent most of each day practicing Vipassana meditation, which focuses on reducing mental distractions and heightening sensory awareness.

Before and after the retreat, participants performed a task in which they looked for one or two numbers mixed into a series of letters flashed on a computer screen. Electrodes on each person's scalp measured neural activity on the brain's surface during the task. In some trials, two numbers appeared less than one-half second apart.

Because visual perception oscillates between focus and interpretation, paying close attention to one object flashed on a computer screen often causes people to overlook a second object presented within the next half second. Scientists suspect that attention momentarily shuts down as the first image is interpreted (perceived). During that "attentional blink", as it is called, the second image sneaks by unnoticed.

Before meditation training, volunteers reported seeing the second of two rapidly presented numbers about 60 percent of the time. After training, they detected the second number, on average, 80 percent of the time. The participants with the greatest meditation-related improvement detected the second number about 90 percent of the time.

Another study by the same group used 23 adults who completed a 1-hour meditation course and then meditated for 20 minutes daily for 1 week before taking their first attention test. Three months later, recipients of the bare-bones training repeated the week of meditation before retaking the test. Performance on the attentional- blink task rose from 60 percent to 70 percent correct.

These findings suggest that intensive meditation training boosts the efficiency of attention-related mental operations.

Meditation and Emotional Stability

Research scientist Philippe Goldin [5] has been training families in mindfulness skills to reduce anxiety and enhance compassion, self-esteem and quality of family interactions.

Mindfulness meditation has been shown to enhance emotional awareness and psychological flexibility as well as induce well-being and emotional balance. Different forms of meditation practices are being studied using neuroscientific technologies and are being integrated into clinical practice to address symptoms of anxiety and depression.

A group of researchers at UCLA [23] who used high-resolution magnetic resonance imaging (MRI) to scan the brains of people who meditate report that certain regions in the brains of long-term meditators were larger than in a similar control group.

Specifically, meditators showed significantly larger volumes of the hippocampus and areas within the orbito-frontal cortex, the thalamus and the inferior temporal gyrus — all regions known for regulating emotions. The chief researcher said, "these might be the neuronal underpinnings that give meditators the outstanding ability to regulate their emotions and allow for well-adjusted responses to whatever life throws their way."

Researchers at at several medical centers [24] used fMRI to examine the right anterior insula, a brain area previously shown to be active during meditation, while experienced meditators were meditating and while they were resting. They found increased activity in that area during meditation in these individuals, as well as more connective activity with brain areas shown to be involved in emotion regulation.

There are also important effects of Meditation on the brain chemistry: studies show that Meditation enhances neurotransmitters in the brain such as Serotonin, Melatonin, and beta-endorphins that are known to be important for positive affect, mood stabilization and the immune system and that are significantly reduced in anxiety and depression.

In his studies on monks, Davidson [3] found that electrical activity was heightened during meditation in an area of the brain called the left prefrontal cortex, just behind the forehead. Scientists have associated activity in this region with positive emotions, as opposed to the right prefrontal cortex, where increases are associated with negative feelings (these areas work in tandem with the ipsilateral amygdala). Davidson has also found that longtime Buddhist practitioners of meditation can induce a heightened pattern of electrical signals called gamma-band oscillations, associated with concentration and emotional control, that are not seen in control groups. These changes
are sustained even after meditating.

In a November 2009 speech, the Dalai Lama made the connection between neuroscientists' research into brain mechanisms associated with attention and emotion and Buddhist meditation that is performed to heighten powers of attention and regulate emotion.

"I feel there might be great potential for collaborative research between the Buddhist contemplative tradition and neuroscience," he said. [26]

Meditation and Memory

College students instructed in meditation displayed significant improvements in performance over a two-week period on a perceptual and short-term memory test involving the identification of familiar letter sequences presented rapidly. They were compared with subjects randomly assigned to a routine of twice-daily rest with eyes closed, and with subjects who made no change in their daily routine. [9]

Studies [25] have shown that regular meditation causes the brain's cerebral cortex to thicken. This happens through an increase in the size of the blood vessels and the amount of blood flow to the region. Brain regions associated with attention and sensory processing were thicker in meditators than in the non-meditators. The observed increases in cortical thickness were proportional to the amount of time the participant had spent meditating over their lifetime.

In 1998, neuroscientist Fred Gage discovered that new cells can, in fact, grow in the adult hippocampus, an area of the brain associated with learning, memory and emotion.

Researchers [2] conducted a series of neurological and memory tests on subjects ranging in age from 52-70, with either a history of memory complaints or a diagnosis of mild cognitive impairment. Single Photon Emission Computed Tomography (SPECT) scans, a brain imaging technique which measures cerebral blood flow, were also conducted on each subject. Following the initial tests, subjects were taught the most widely practiced meditation in the Kundalini Yoga tradition, and instructed to practice a 12-minute meditation each day for eight weeks.

Follow up testing confirmed statistically significant improvements in memory among all of the study's subjects, the most significant outcome of the study was the stark contrast between the pre and post-training SPECT scans. Follow up scans showed dramatic increases in blood flow to the posterior cingulate gyrus, a region of the brain associated with learning and memory. It is the first region of the brain to decline in individuals diagnosed with Alzheimer's disease, which helps to explain why the blood flow-producing meditation has such a profound impact on cognitive functioning.

Meditation and Increased Creativity

One recent study used the Torrance Test of Creative Thinking to measure figural and verbal creativity in a control group and in a group that subsequently learned meditation. On the post test five months later, the meditation group scored significantly higher on figural originality and flexibility and on verbal fluency. [19]

Evidence (primarily from EEG studies [27]) supports the hypothesis that meditation training variously enhances creative incubation and illumination via transcendence and integration, neuropsychological mechanisms common to both processes. Transcendence surpasses informational limits; integration transforms informational boundaries. Increased low-alpha power reflects reduced cortical activity and detached witnessing of multimodal information processing; theta indicates an implicit affect-based orientation toward satisfaction and encoding of new information; delta reflects neural silence, signal matching and surprise, and gamma indicates heightened awareness, temporal-spatial binding, and salience.

Cortical intra-interhemispheric synchronization, within these EEG spectral bands, is essential to effective creativity. Sanyama, an ancient yogic attentional technique embodying both transcendence and integration, provides a unique neuropsychological explanation for extraordinary creativity.

Meditation and Intellect

University students who regularly practiced meditation increased significantly in IQ over a two-year period, compared to control subjects. The finding corroborates the results of two other studies showing increased IQ in meditation students. [10]

Meditation and Self Esteem

Self-actualization refers to realizing more of one's inner potential, expressed in every area of life. A statistical meta-analysis of 42 independent studies indicated the effect of meditation on increasing self-actualization is markedly greater than that of other forms of relaxation. This analysis statistically controlled the length of treatment and quality of research design. [20]

One month after beginning meditation, subjects experienced an improved self-concept in comparison to before learning meditation. Meditation participants developed a more strongly defined self-concept and also came to perceive their "actual self" as significantly closer to their "ideal self." No similar changes were observed for matched controls.[21]

Meditation and Ageing

Biological age measures how old a person is physiologically. As a group, long-term meditators who had been practicing meditation for more than five years were physiologically twelve years younger than their chronological age, as measured by reduction of blood pressure, and better near-point version and auditory discrimination. Short-term meditators were physiologically five years younger than their chronological age. The study controlled for the effects of diet and exercise.[22]

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General Health

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